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Response of weed management on, nutrient uptake and economics in fenugreek (*Trigonella foenum graecum* L.) Under south Gujarat condition

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Abstract
An experiment was conducted at Navsari during 2007-08 with 10 weed management treatments to study the effect of weed management in fenugreek (*Trigonella foenum graecum* L.) under South Gujarat condition. The highest seed (1348 kg ha^{-1}) and straw (3100 kg ha^{-1}) yields were recorded under treatment of weed free up to harvest (W_3) being at par with Pendimethalin @1.0 kg ha^{-1} + hand weeding at 40 DAS (W_5). Pendimethalin @ 1.0 kg ha^{-1} + hand weeding at 40 DAS (W_5) and Pendimethalin @ 1.0 kg ha^{-1} (W_4) found most effective with the lowest dry weight of weeds of 552.50 and 622.25 kg ha^{-1}, with higher weed control efficiency of 68.12 and 64.13 per cent, lower weed index of 8.50 and 23.12 per cent, respectively, while treatment unweeded control recorded the highest dry weight of weeds (1738.00 kg ha^{-1}) and higher weed index (50.28%) at harvest. The highest (21.84, 13.02 and 9.55 kg NPK ha^{-1}) and the lowest (4.93, 3.47 and 2.15 kg NPK ha^{-1}) nutrients removal by weeds were recorded under treatment unweeded control (W_0) and pendimethalin @ 1.0 kg ha-1 + hand weeding at 40 DAS (W_5), respectively. The highest net profit (Rs. 20486 ha^{-1}) was obtained from treatment of weed free up to harvest (W_3) followed by treatment of pendimethalin @ 1.0 kg ha^{-1} + one hand weeding at 40 DAS (Rs. 17861 ha^{-1}) and Pendimethalin @ 1.0 kg ha^{-1} (Rs. 14309 ha^{-1}). While the highest cost benefit ratio (3.52) was obtained under treatment of weed free up to harvest followed by treatments pendimethalin @ 1.0 kg ha^{-1} + one hand weeding at 40 DAS (3.14).

Keywords: Fenugreek, Leguminosae, hand weeding, pendimethalin, yield

Introduction
Fenugreek (*Trigonella foenum graecum* L.) known as *methi*, belongs to the Leguminosae families. It contains about 13.7% water, 26.2% protein, 5.8% fat, 3.0% mineral matter, 7.2% fibres, 4.41% carbohydrate, 0.16% calcium and 0.37% phosphorus. Fenugreek being a leguminous crop, fix a good amount of nitrogen. Its seeds are used as condiments and vegetable for human consumption and as a concentrate for cattle. The seeds are aromatic, tonic and galactogogue, so it is widely used as medicinal plant. It green leaves are used as vegetable, while chopped leaves are mixed in flour to prepare delicious preparation. Besides, it is used as an ayurvedic medicine for curing stomach ailments, especially the imported steroid "diosgenin" which is extracted from fenugreek seed. Seeds are better in taste to the presence of two alkaloids "Trigonelline" and "Choline". Being a legume, its roots are endowed with a mini-factory to synthesize nitrogenous food for the plant (Agrawal, 2001) [1].

Among the several factors responsible for low yield of pulse crops in India. Weed infestation is one of the major factors. Weed growth is an important constraint whose rapid growth leads to severe crop-weed competition for light, moisture, space and nutrients. In agriculture, weeds cause more damage compared to insects, pests and diseases, but due to hidden loss caused by weed in crop production, it has not drawn attention of agriculturists. Weeds compete with fenugreek and reduce the seed yield up to 91 per cent (Mali and Suwalka, 1987) [5]. The predominant method of weed control by mechanical hoeing and manual weeding is found to be labourios and time consuming, not only this but in the peak period of crop growth, labors are not easily available and incessant rains during rainy season do not permit farm operations in time. Under this situation chemical control of weed is found to be effective and economical. The uses of herbicides provide better agricultural practices. Unfortunately, until now majority of the farmers are not knowing the proper doses of herbicides, time of application and their economics, so that weed control so far as their judicious use is concerned.

Weed problem varies from crop to crop, region to region and also depends on soil type, fertility status of soil as well as agro climatic conditions.

Material and Method

The field experiment was conducted in deep black soil of the Instructional Farm, Navsari Agricultural University, Navsari during the *rabi* season of the year 2008. Ten treatments comprised *viz*., Unweeded control (W_1), One HW at 20DAS (W_2), W_1 + One HW at 40 DAS (W_3), Weed free up to harvest (W_4), Pendimethalin as pre-emergence @1.0 kg ha^{-1} (W_5), W_5 + One HW at 40 DAS (W_6), Quizalofop ethyl@ 40 g ha^{-1} as post-emergence at 20 DAS (W_7), Quizalofop ethyl@ 40 g ha^{-1} as post emergence at 30 DAS (W_8). Imazethapyr @ 75 g ha^{-1} as post emergence at 20 DAS (W_9), Imazethapyr @ 75 g ha^{-1} as post emergence at 20 DAS (W_{10}). These treatments were replicated four times in Randomized Block Design. The soils was low in available nitrogen (138.20 kg ha^{-1}) and organic carbon (0.45%) and high in available P (32.63kg ha^{-1}), available K (410 kg ha^{-1}) with pH 7.6. Fenugreek (cv. Gujarat fenugreek-1) was shown on 3rd November, 2007 in row 30 cm apart and seeds were placed at a depth of 3.0 cm using 20 kg seed ha^{-1}. A full dose of N (20 kg ha^{-1}) and P (40 kg ha^{-1}) were applied in furrow at a depth of 7 to 8 cm just before the sowing. Required quantity of different herbicides were calculated and mixed with water @600 liters per hectare as per treatment and sprayed on soil. The herbicides pendimethalin was applied as pre-emergence and Quizalofop-ethyl and Imazethapyr were applied as post emergence, respectively. Plant protection measures and irrigations were followed as per recommendation. Weed count (No. /m^2) and weed dry weight (g/m^2) were recorded by putting a quadrate (0,25m^2) at two random spots in each plot at harvesting stage of crop. Nutrient uptake by weeds and crop were calculated on the basis of dry matter yield with the nutrient content. Weed control efficiency (WCE) was also calculated on the basis of dry matter production of weeds. The crop was harvested on 29th February 2008. The experimental data recorded for yields were statistically analyzed. Data on weed density and dry weight of weeds were transformed using $\sqrt{(x+0.5)}$ before statistical analysis.

Results and Discussion

The experimental field was infested by number of weed species comprising of monsoon weeds *viz., Digitaria sanguinalis* L., *Polycarpaea corymbosa* Scop., *Cynodon dactylon* (L.) and *Eragrostis* major dicot weeds *viz., Amaranthus viridis* L., *portulaca oleracea* L., *Euphorbia hirta* L., *Lanaea musically* H. K., *Amaranthus spinosus* L., *Digera arvensis* Forsk., *Melilotus alba* Lamk., *Chenopodium album* L., *Physalis minima* L., *Phyllanthus niruri* L. and among sedge *Cyperus rotundus* L. were predominantly present. All weed management treatments significantly reduced the population of weeds compared to unweeded control. Treatment of weed free up to harvest (W_3) registered the lowest weed population (Table-1) at all stages of growth (30, 60 DAS and at harvest) which was closely followed by treatment W_5 (Pendimethalin @ 1.0 kg ha^{-1} + one hand weeding at 40 DAS) and W_4 (Pendimethalin @ 1.0 kg ha^{-1}). In addition to this, dense crop canopy might have also smothering effect on weeds. The findings are confined with those reported by Chaudhary (1999) [2] and Ramana *et al.* (1994) [10].

The dry weight of weeds (Table-1) recorded at 60 DAS (g m^{-2}) and at harvest (kg ha^{-1}) was reduced significantly by all the weed management treatment as compared to unweeded control (W_0). Treatment of weed free up to harvest (W_3) recorded the lowest dry weight of weeds (0.00 g m^{-2}) at 60 DAS and at harvest closely followed by treatments W_5 (Pendimethalin 1.0 kg ha^{-1} + one hand weeding at 40 DAS), 69.50 g m^{-2} and 552.50 kg ha^{-1}, respectively. Better weed control efficiency of these herbicides along with hand weeding resulted into the lowest weed count and finally reduced the dry weight of weeds at harvest. Similar results were also reported by Ramana *et al*. (1994) [10] and Chaudhary (1999) [2].

As per the Table-1 highest weed control efficiency (100%) at 60 DAS was recorded under treatment W_5 (64.70%) and W_4 (61.23%). While at harvest W_3 (weed free up to harvest) registered the maximum (100%) weed control efficiency followed by W_4 (64.13%) and W_5 (68.12%). This might be due to residual effects of herbicides resulted in remarkably reduction in weed population and ultimately low dry weights of weeds observed under these treatments were responsible for weed control efficiency. These results are confirmed by those reported by Zalavadia *et al*. (1999) [12], Chaudhary (1999) [2] and Gill *et al*. (2002) [3]. Looking to weed index which is the indicator of losses in seed yield due to presence of weeds, treatment W_5 (Pendimethalin @ 1.0 kg ha^{-1} + one hand weeding at 40 DAS) recorded the lowest weed index (8.50%) followed by W_4 (Pendimethalin @ 1.0 kg ha^{-1}). This might be due to effective weed control achieved under these weed management treatments in terms of reduced biomass of weeds and higher weed control efficiency. Almost similar results were also reported by Mali and Suwalka (1987) [5] and Gill *et al*. (2002) [3].

Different weed management treatments showed significant influence on uptake of major nutrients *i.e*., nitrogen, phosphorus and potassium by seed, haulm and weed at harvest. Significantly the lowest uptake of nitrogen, phosphorus and potassium by seed and haulm were noted under unweeded control (Table-2). The highest uptake of nutrients were recorded under treatment W_3 (weed free up to harvest). This might be due to better development of crop resulting from lesser crop weed competition, further, the higher content and higher dry matter accumulation by crop under these treatments boosted the nutrient uptake. Similar results were reported by Raghvani *et al*. (1987a) and Thakaral *et al.* (1995). Similarly, significantly the highest removal of nutrients (21.84, 13.02 and 9.55 NPK kg ha^{-1}) by weed (Table-2) were recorded under W_0 (Unweeded control), whereas the lowest nutrient depletion by weeds were recorded under treatments W_3 (weed free up to harvest), W_5 (Pendimethalin @ 1.0 kg ha^{-1}). Similar results were also reported by Raghvani *et al*. (1987b) and Maliwal and Gupta (1989).

Seed yield (1347 kg ha^{-1}) and straw yield (3100 kg ha^{-1}) were recorded significantly highest (Table-3) under treatment of weed free up to harvest (W_3) being at par with treatments W_5 (Pendimethalin @ 1.0 kg ha^{-1} + one hand weeding at 40 DAS) and W_4 (Pendimethalin @ 1.0 kg ha^{-1}). The remarkable increase in seed and straw yields under these treatments (W_3, W_5 and W_4) might be due to effective control of weeds reduced dry weight of weeds with higher weed control efficiency as well as lower weed index which cumulative facilitated the crop to utilize more nutrients and water for better growth and development measured in terms of various growth and yield attributing characters. All these parameters showed positive and highly significant influence on seed yield of fenugreek, besides minimum depletion of nutrients by

weeds and better uptake by fenugreek which might be cumulatively reflected in higher seed and stover yields of fenugreek. These findings are in close agreement with those reported by Mali and Suwalaka (1997), Ramana *et al*. (1994) [10] and Gill *et al*. (2002) [3].

The highest net realization of Rs. 20,486 ha^{-1} was obtained in treatment of weed free up to harvest (W_3) with CBR value of 1:3.52 followed by W_5 (Pendimethalin as pre-emergence @ 1.0 kg ha^{-1} with one hand weeding at 40 DAS with net realization of Rs. 17862 ha^{-1}. The lowest net realization of Rs. 8575 ha^{-1} was noted in treatment W0 (Unweeded control) with CBR vale of 1:2.40 (Table-3).

Table 1: Effect of weed management practices on weed population, dry weight, weed control efficiency and weed index in fenugreek crop

Treatments	Weed population per Sq. m.			Dry weight of weeds		Weed control efficiency (%)		Weed index (%)
	30 DAS	60 DAS	At harvest	60 DAS (g m^{-2})	At harvest (kg ha^{-1})	60 DAS	At harvest	
W_1- Unweeded control	16.57	18.71	20.71	196.73	1738.00	0.00	0.00	50.28
W_2- One HW at 20DAS	15.58	16.28	20.24	143.25	1247.50	26.73	27.54	40.37
W_3- W_1 + One HW at 40 DAS	14.21	17.05	19.65	127.00	1085.00	35.42	35.56	31.14
W_4- Weed free up to harvest	3.00	3.00	3.00	0.00	0.00	100.00	100.00	0.00
W_5-Pendimethalin as pre-emergence @1.0 kg ha^{-1}	5.61	6.18	7.56	76.00	622.25	61.23	64.13	23.12
W_6- W_5 + One HW at 40 DAS	4.55	5.14	5.79	69.50	552.50	64.70	68.12	8.50
W_7-Quizalofop ethyl@ 40 g ha^{-1} as post-emergence at 20 DAS	13.36	15.14	13.77	94.00	742.50	52.11	57.18	27.92
W_8-Quizalofop ethyl@ 40 g ha^{-1} as post emergence at 30 DAS	9.93	1.25	11.55	87.60	688.50	55.26	60.20	26.60
W_9-Imazethapyr @ 75 g ha^{-1} as post emergence at 20 DAS	13.81	15.52	15.47	96.00	760.00	51.17	56.18	28.84
W_{10}-Imazethapyr @ 75 g ha^{-1} as post emergence at 20 DAS	11.56	12.23	13.24	88.25	695.00	55.00	59.87	2.34
S. Em. +	0.368	0.399	0.487	4.235	39.224	--	--	--
C. D. at 5 %	1.07	1.16	1.410	12.29	113.80	--	--	--

Table 2: Nitrogen, phosphorus and potassium uptake (kg ha-1) by seed and haulm of fenugreek and weeds as influenced by various weed management treatments

Treatments	Nitrogen (kg ha^{-1})			Phosphorus (kg ha^{-1})			Potassium (kg ha^{-1})		
	Seed	Haulm	Weeds	Seed	Haulm	Weeds	Seed	Haulm	Weeds
W_1- Unweeded control	23.70	20.73	21.84	2.10	2.36	13.02	2.22	2.77	9.55
W_2- One HW at 20DAS	29.95	24.68	14.94	2.58	2.77	9.22	2.85	3.37	7.01
W_3- W_1 + One HW at 40 DAS	34.10	27.09	12.57	3.05	3.19	7.85	3.79	4.21	5.73
W_4- Weed free up to harvest	58.14	64.38	0.00	5.48	7.68	0.00	6.87	9.97	0.00
W_5-Pendimethalin as pre-emergence @1.0 kg ha^{-1}	41.85	55.78	5.75	4.01	6.86	4.10	4.88	8.88	2.24
W_6- W_5 + One HW at 40 DAS	52.40	60.81	4.93	4.89	7.20	3.47	6.14	9.27	2.15
W_7-Quizalofop ethyl@ 40 g ha^{-1} as post-emergence at 20 DAS	35.20	34.72	7.01	3.39	4.26	5.19	4.16	5.36	3.40
W_8-Quizalofop ethyl@ 40 g ha^{-1} as post emergence at 30 DAS	37.36	46.77	6.45	3.75	5.94	4.60	4.64	7.61	3.60
W_9-Imazethapyr @ 75 g ha^{-1} as post emergence at 20 DAS	35.57	38.25	7.34	3.26	4.52	5.19	3.66	5.23	3.22
W_{10}-Imazethapyr @ 75 g ha^{-1} as post emergence at 20 DAS	37.95	49.95	6.60	3.56	5.64	4.51	4.40	7.25	3.55
S. Em. +	1.56	2.43	0.68	0.21	0.29	0.87	0.27	0.38	0.29
C. D. at 5 %	4.53	7.05	1.99	0.62	0.87	1.07	0.77	1.09	0.85

Table 3: Yield and economics of fenugreek as influenced by various weed management treatments

Treatments	Yield (kg ha^{-1})		Cost of cultivation (Rs. ha^{-1})			Gross realization (Rs. ha^{-1})			Net realization (Rs. ha^{-1})	Cost-benefit ratio
	Seed	Haulm	Fixed	Variable	Total	Seed	Haulm	Total		
W_1-Unweeded control	669	2638	6119	6119	--	13375	1319	14694	8575	1:2.40
W_2-One HW at 20DAS	806	2678	6119	6619	500	16125	1349	17464	10845	1:2.64
W_3-W_1 + One HW at 40 DAS	925	2710	6119	6869	750	18500	1355	19855	12986	1:2.89
W_4-Weed free up to harvest	1347	3310	6119	8119	2000	26950	1655	28605	20486	1:3.52
W_5-Pendimethalin as pre-emergence @1.0 kg ha^{-1}	1030	3100	6119	7846	1727	20605	1550	22155	14309	1:2.82
W_6-W_5 + One HW at 40 DAS	1229	3255	6119	8348	2227	24580	1628	26207	17862	1:3.14
W_7-Quizalofop ethyl@ 40 g ha^{-1} as post-emergence at 20 DAS	970	2885	6119	7367	148	19400	1443	20843	13476	1:2.83
W_8-Quizalofop ethyl@ 40 g ha^{-1} as post emergence at 30 DAS	987	3038	6119	7367	1248	19745	1519	21764	13897	1:2.89
W_9-Imazethapyr @ 75 g ha^{-1} as post emergence at 20 DAS	958	2761	6119	7494	1375	19160	1381	20541	13047	1:2.74
W_{10}-Imazethapyr @ 75 g ha^{-1} as post emergence at 20 DAS	962	2940	6119	7494	1375	19245	1470	20715	13221	1:2.76
S. Em. +	41.320	103.99	--	--	--	--	--	--	--	--
C. D. at 5 %	119.88	301.72	--	--	--	--	--	--	--	--

Conclusion

From the results it can be concluded that to obtain higher profitable yield of fenugreek, it should be kept weed free by two hand weedings and interculture operations or only two hand weedings at 20 and 40 DAS. In area there is paucity of labour, it is advisable to apply pendimethalin @ 1.0 kg ha^{-1} as pre-emergence supplemented with one hand weeding at 40 DAS under South Gujarat conditions.

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